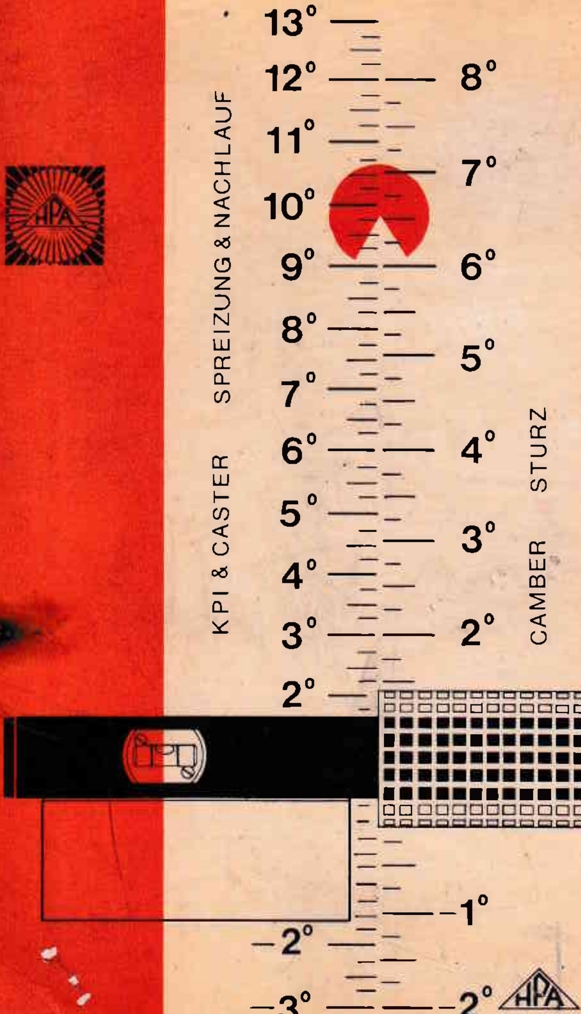
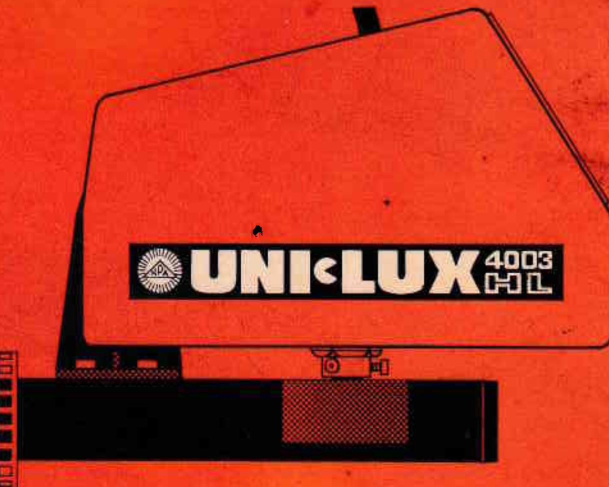
UNI-LUX 4003 HL





HPA UNI-LUX

The HPA UNI-LUX has been specially designed to fill the need for a small and handy optical wheel alignment unit.

In spite of the small dimensions a most accurate reading is obtained by means of the special lens attachement.

The UNI-LUX is extremely easy to operate and an alignment check can be made in a few minutes. The instructions have been made so detailed in order to ensure a rational working procedure.

Before taking the unit into use it should be checked as indicated on the last pages of the manual.

H. P. Andersen . Engineering Ltd.

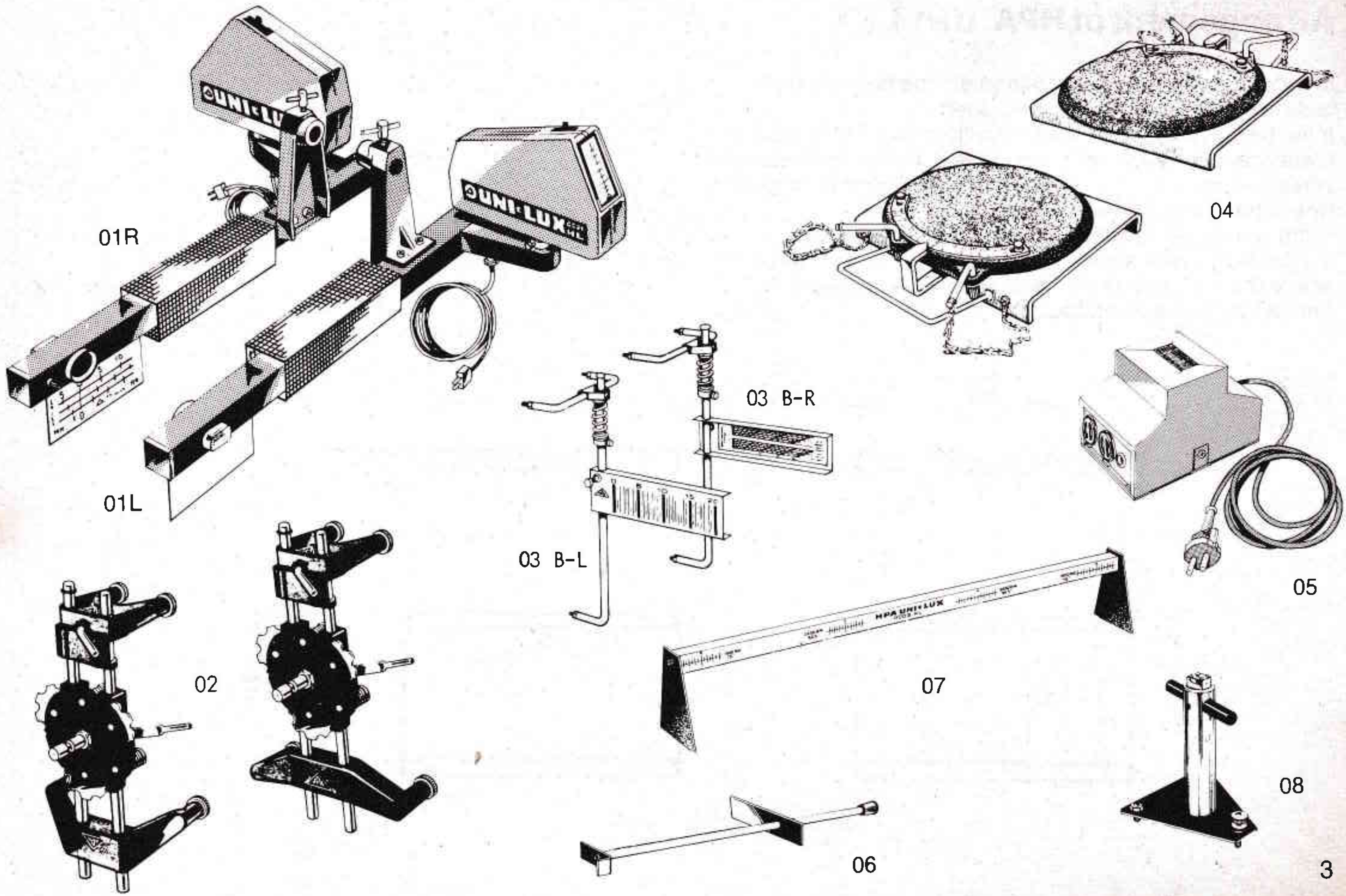
28, Egegårdsvej . DK 2610 Rødovre, Denmark

1984.8

Index

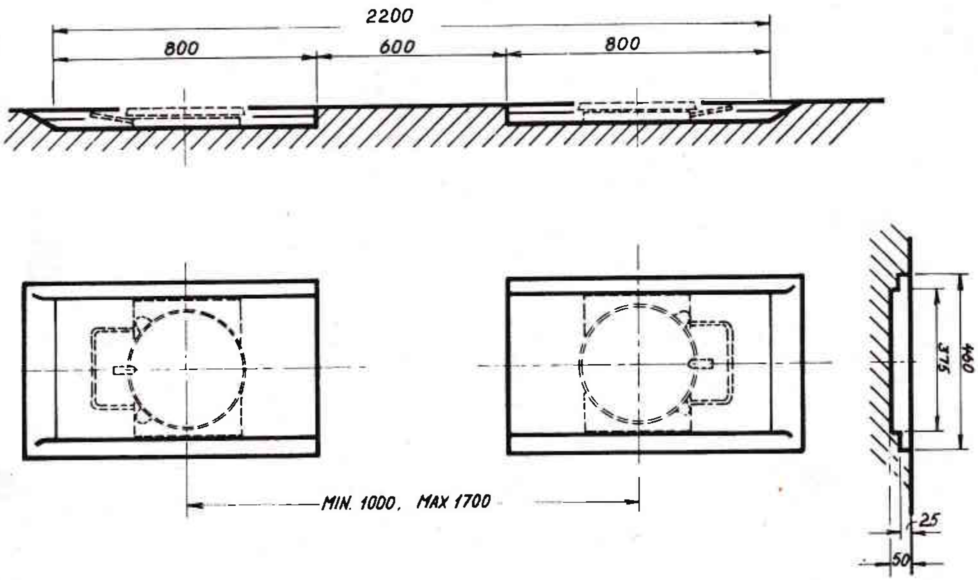
HPA UNI-LUX is supplied complete with the following accessories:

01	RH	Measuring Unit
01	LH	Measuring Unit
02		Mounting Fixtures with run-out Compensator
03	B	RH Indicator
03	B	LH Indicator
04		Turntables with Gradings HPA-622-B or HPA-622-C, respectively (for maximum 2,5 tons axle load).
05		Transformer Box
06		Brake Pedal Depressor
07		Checking Rod
08		Checking Stand

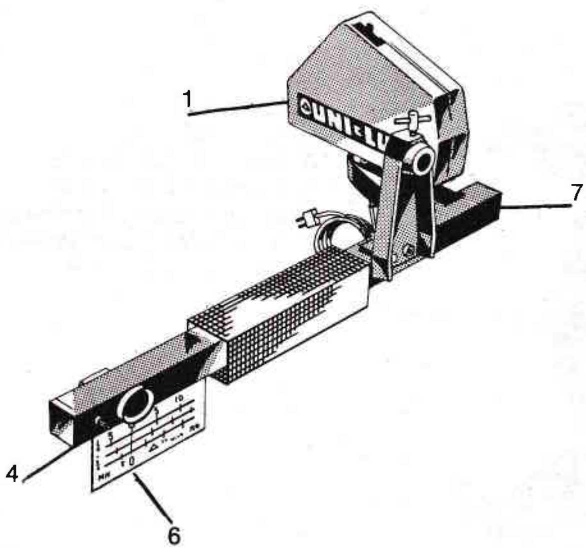

01R
01L
02
03 B-R
03 B-L
04
05
06
07
08
UNI·LUX
HPA UNI·LUX

Arrangement of HPA UNI-LUX

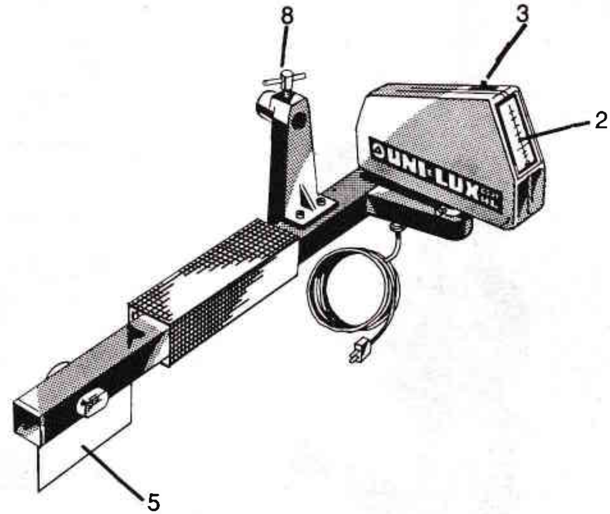
In order to ensure a correct alignment the floor must be level, where the car wheels are placed.
If the turntables are placed on the floor or on a lift, it is therefore necessary to place ramps under the rear wheels of the car. The ramps must be 50 mms. high (the hight of the turntables).
If the turntables are to be placed flush with the floor, the drawing below shows the procedure. The floor area where the rear wheels are positioned must be level with the surface of the turntables.



Measuring Units



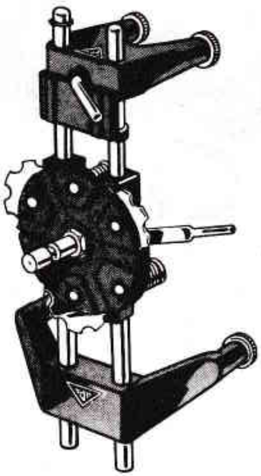
RH

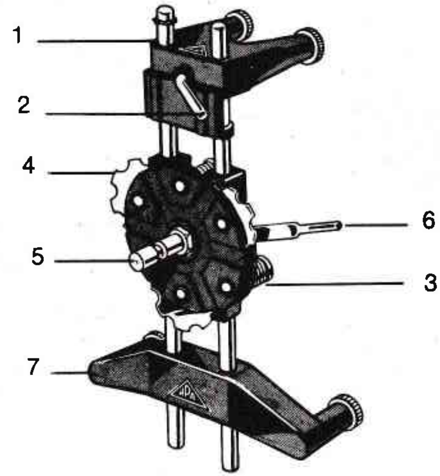


LH

1. Angle Measuring Unit.
2. Scale for CAMBER, CASTER, and KING PIN Inclination.
3. Control lever for measuring CAMBER & CASTER.
4. Adjusting knob for measuring of TOE-IN.
5. Scale for TOE-IN on RH wheel.
6. Scale for TOE-IN on LH wheel.
7. Parallel-Projectors directed to the rear.
8. T-Key for fastening the unit.

Mounting fixtures for the measuring unit

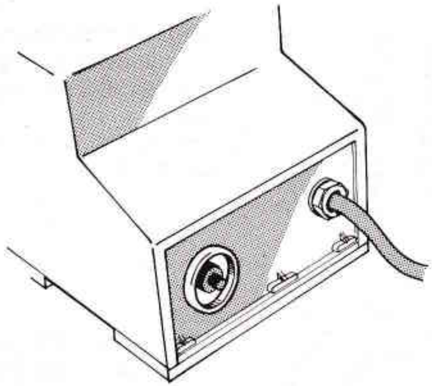




1. Loose beam.
2. Cam lock.
3. Run-out compensator.
4. Compensator screw.
5. Mounting pivot for measuring unit.
6. Eccentric for compensator.
7. Supporting bracket.

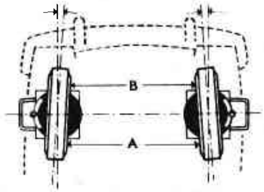
With 10″–14″ wheels the supporting bracket (7) must be mounted as shown in the illustration to the left.
With 15″ and 16″ wheels mount the supporting bracket as shown in the illustration to the right.

Transformer box with built-in thermal fuse

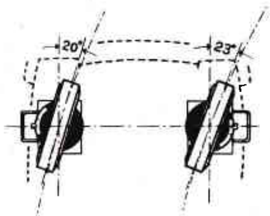


The standard transformer is for 220 V mains supply.
Output voltage: 12 V
Comsumption: 150 W
On request a special transformer with 4 tappings is available, suitable for mains voltages of 200 – 220 – 240 – 270 V.

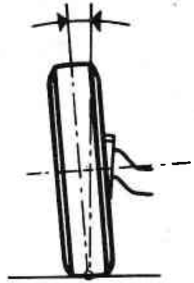
Wheel angles



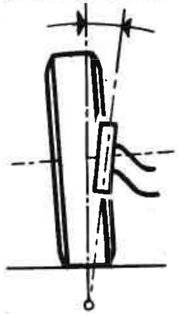
TOE-IN
The difference between A and B in mms. or inches.
If B is smallest, TOE-IN is positive.
If A is smallest, TOE-IN is negative.
The measuring unit indicates TOE-IN measured at the edge of the rim, which corresponds to the specifications of the car factories.
TOE-IN can also be stated as the angle between straight-forward position and inward (positive) or outward (negative) turning of the wheels.
See conversion table from grades to mms. and inches page 43.



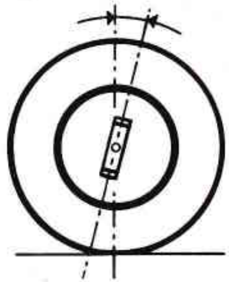
TOE-OUT on turns
The difference between the turning angle of the wheels in curves.
The angle of the inner wheel in a curve should be the biggest as it runs in a smaller circle.
TOE-OUT is measured on the scale of the turntables.



Camber
Inclination of the wheel from vertical position measured in degrees.
Inclination outwards –
Camber positive
Inclination inwards –
Camber negative



King Pin Inclination (KPI)
Inclination of king pin from vertical position measured in degrees.
Inclination inwards =
KPI positive.



Caster
Inclination of king pin from vertical position in lengthwise direction measured in degrees.
Inclination backwards –
Caster positive
Inclination forwards –
Caster negative

Wheel alignment charts can be obtained from HPA.

Operating instructions

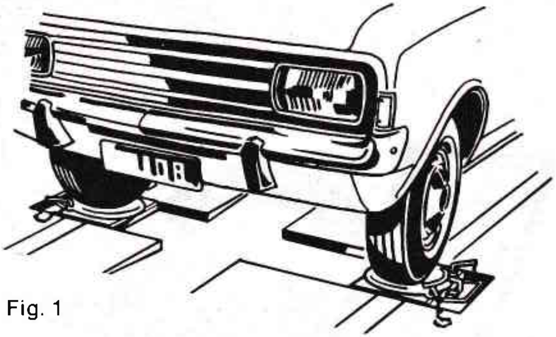


Fig. 1

Drive the car straight onto the turntables. Check the tyre pressure on all wheels. If prescribed, the car must be loaded. It is practical to check the front wheels for untrue rims before placing the turntables on the floor.

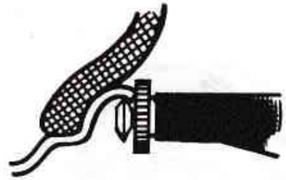


Fig. 2

Adjust the cut screws until a perfect grip on the edge of the wheel rim is obtained.
Take care that the lock nuts are tightened.
All 4 lock nuts must lie true against the edge of the rim.

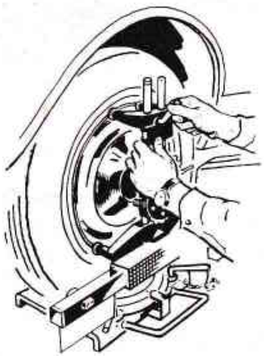


Fig. 3

Attach the measuring units to the front wheels. Pressing the loose beam upwards lock the eccentric handle. Shake the rods to make sure that the measuring units are clamped securely.

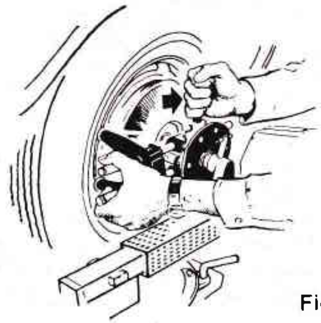


Fig. 4

Jack up the front wheels. Slide the compensator until the pivot centres. Tighten the eccentric carefully.

Compensating for untrue rims

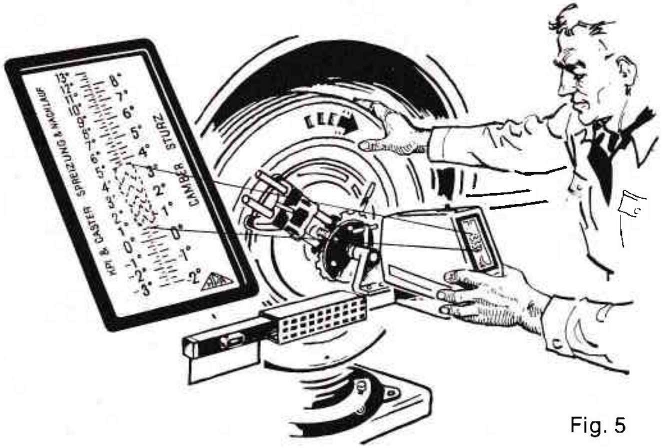


Fig. 5

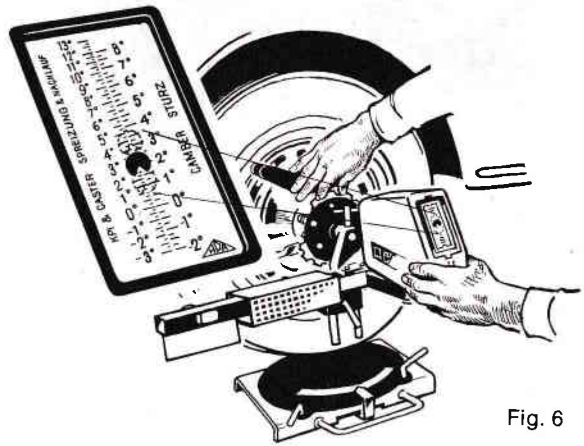


Fig. 6

Connect the measuring units to the transformer.
Turn the angle measuring unit to locking position at a right angle to the wheel. Rotate the wheel slowly.
If the rim is untrue, the light image will move up and down. In that case compensation must be made as incicated at fig. 6.

Stop the wheel when the light image reaches one of the outer positions. Adjust the upper or lower compensator screw until the light image is in the centre of the deflection. If the compensator screw does not allow sufficient adjustment, adjust by turning the remaining two screws equally much. Rotate the wheel again. The light image must not move now. If the wheel wobbles, this must be corrected before further alignment is made.

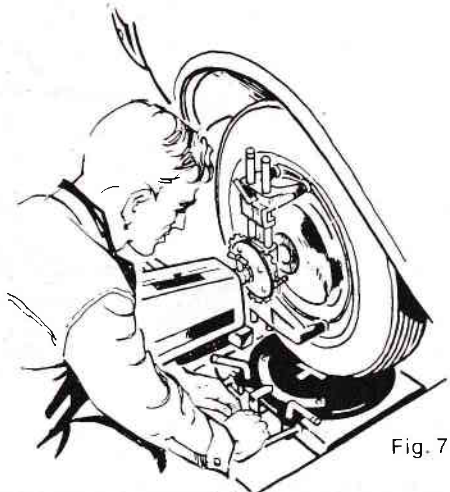


Fig. 7

Lower the front wheels slowly onto the centre of the turntables.
The rods of the clamps must be in vertical position.



Fig. 9

Bump the car up and down a few times.

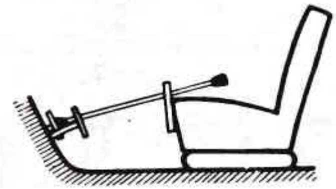


Fig. 8

Apply the brake pedal depressor. The front wheels must remain locked during the alignment procedure.



Fig. 10

Unlock the turntables by removing the locking pins.
Bump the car a few times again.

Measuring of TOE-IN

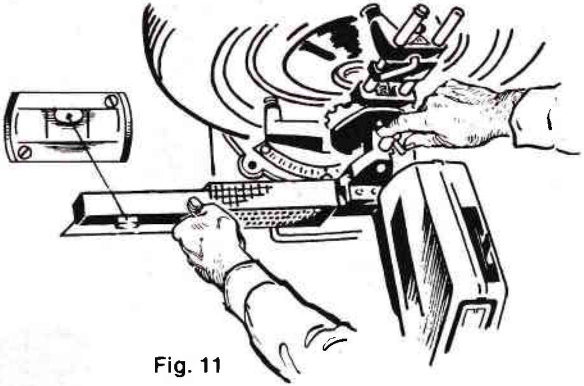


Fig. 11

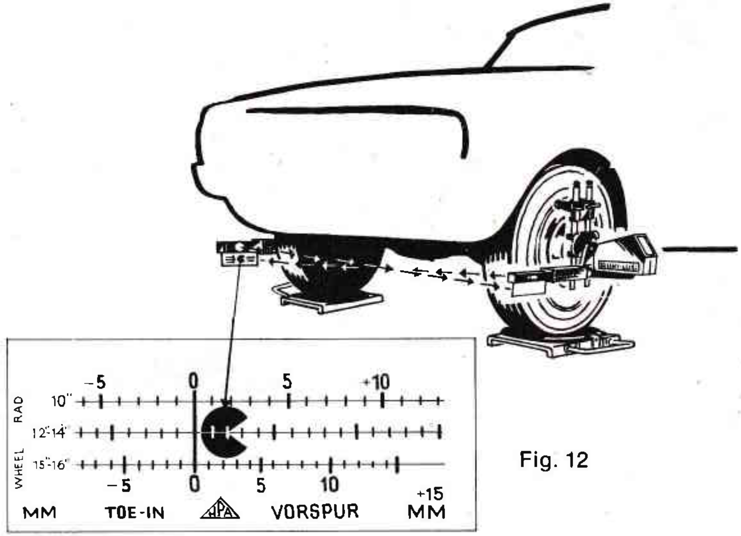


Fig. 12

Turn the front wheels into straight-forward position. True up both measuring units and tighten the T-key.

Tilt the TOE-IN adjusting knob so that the light images hit the TOE-IN scales. The light image must be focused on the horizontal red line which marks the wheel size. Turn the wheels so that the light image hits the zero line of the scale. The total TOE-IN of the front wheels can now be read direct on the other side.

Fig. 12 shows a 2 mm. positive TOE-IN for 12"–14" wheels.

The measuring units must always be trued up when measuring TOE-IN or Camber.

When measuring Caster and KPI the spirit level is not used.

Centering of the steering wheel

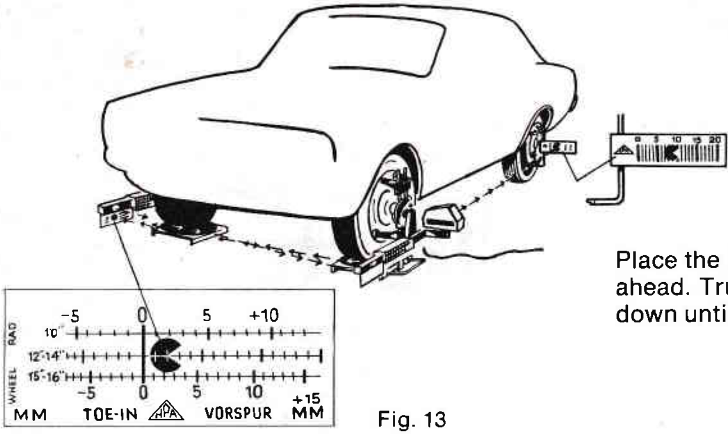


Fig. 13

Place the indicators on the rear wheels. Turn the front wheels straight ahead. True up the measuring units. Slide the indicator scales up or down until the light images are focussed (fig. 13).

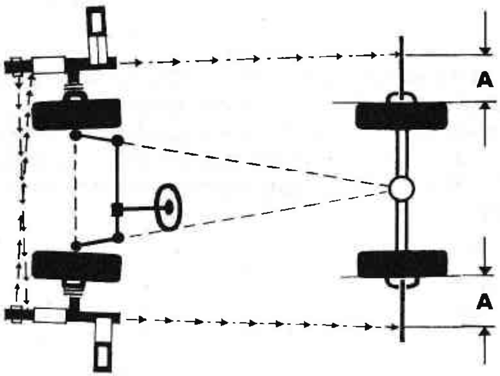


Fig. 14

Turn the front wheels until the same value is obtained on both indicator scales (fig. 14).

The front wheels now have the same TOE-IN in relation to the lengthwise axis of the car and the steering wheel must be in neutral position.

If not, adjustment must be made on the track bars without changing the position of the wheels.

If the car has one adjustable track bar only, it is necessary to turn the steering wheel on the shaft.

The total TOE-IN of the wheels should remain correct.

Measuring of set-back of front axles

SET-BACK is measured in relation to the geometrical center line connecting the mid points of front and rear axles.

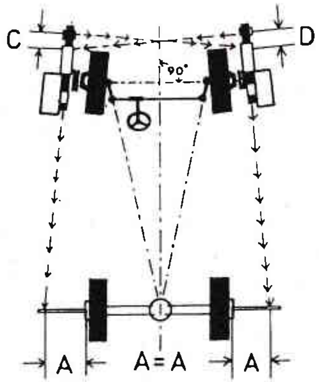


Fig. 14a

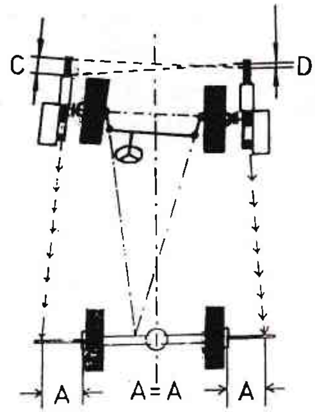


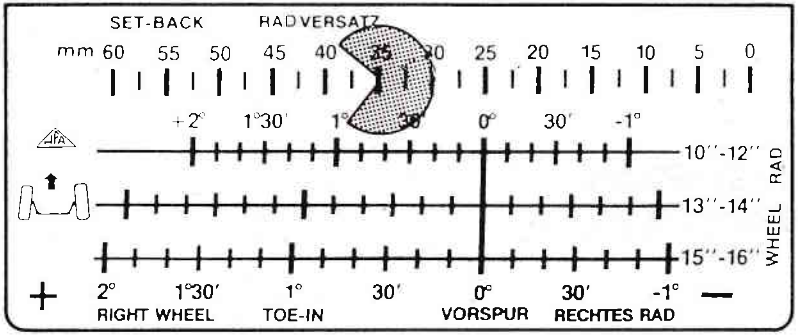
Fig. 14b

Attach the indicators to the rear wheels in such a way that the scales with the straight gradings are turned towards the front wheels.
True up the measuring units.
Slide the scales up or down until the light images are focused.
Turn the front wheels until you obtain the same reading on both indicator scales.
If the TOE-IN value is identical on both wheels as shown on the illustration, the front axle is at a right angle to the geometrical center line of the car.

The illustration shows a car where the front axle is not at a right angle to the geometrical center line.
Consequently the readings »C« and »D« are different.
The SET-BACK value is read from the upper gradings of the TOE-IN scales and you deduct one reading from the other.

EXAMPLE of SET-BACK

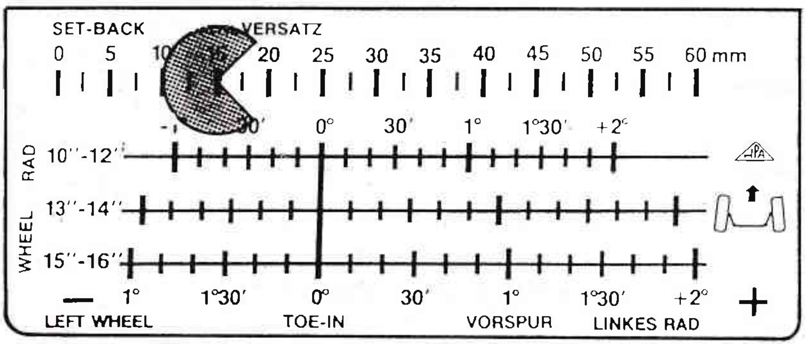
TOE-IN scale on L.H. measuring unit.



»C« reading.

»C« reading = 35 mm
»D« reading = 15 mm
SET-BACK = »C« – »D«
(35 – 15 mm) = **20 mm**

TOE-IN scale on R.H. measuring unit.



It is the wheel for which you obtain the smaller reading that is set back.

»D« reading.

CAMBER

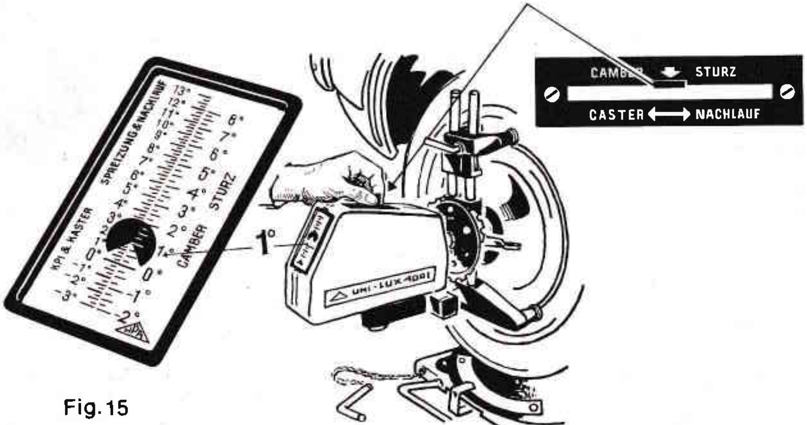


Fig. 15

Turn the front wheels so that they have the same TOE-IN.
True up the measuring units.
The measuring unit must be locked at a right angle to the wheel.
Place the control lever in the locking notch.
Read CAMBER on the right side of the scale.
Fig. 15 shows 1° positive CAMBER.
Read CAMBER in the same way for the other wheel.

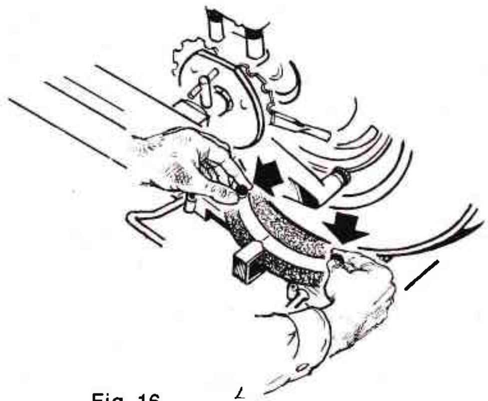


Fig. 16

Zero-adjust the scales of the turntables when the front wheels have the same TOE-IN.

Fig. 17



Turn the LH wheel
20° inwards.

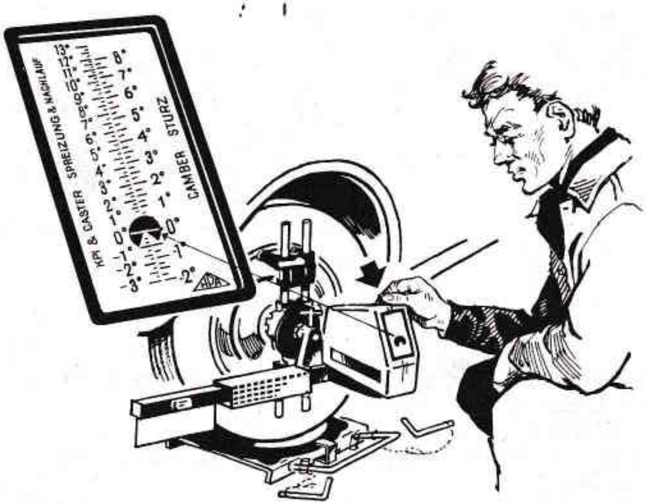


Fig. 18

Adjustment for measuring of Caster
Slide the control lever of the measuring unit until the light image is on the zero-line of the scale.

Caster and King Pin Inclination (KPI)

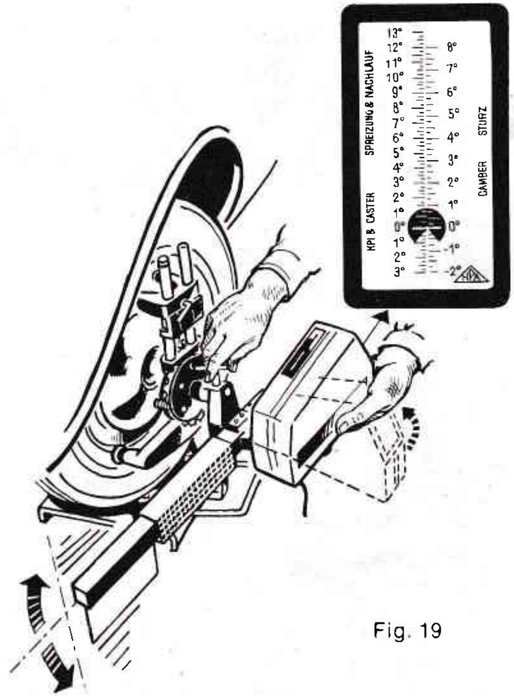


Fig. 19

Adjustment for measuring of KPI
Turn the measuring unit backwards to locking position parallel to the wheel.
Loosen T-key and tilt the unit until the light image is focused on the zero-line of the scale. Tighten T-key. Be careful not to touch the control lever, otherwise your Caster value will be incorrect.



Fig. 20

Turn the wheel 20° outwards. Take care that the adjustment of the measuring unit is not altered.

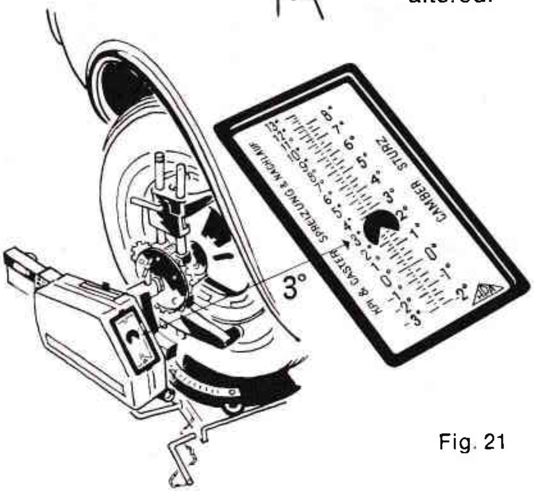


Fig. 21

Take KPI reading on the left side of the scale.
Fig. 21 shows 3° positive KPI.

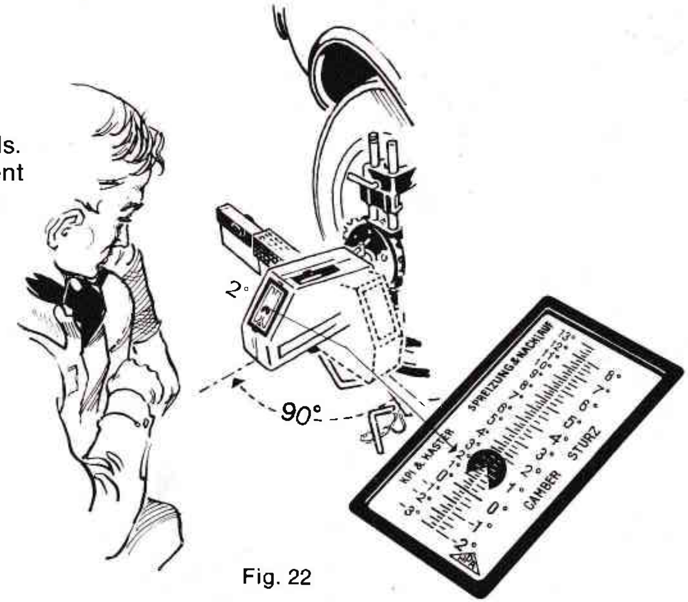


Fig. 22

Lock the measuring unit at a right angle to the wheel.
Read Caster on the left side of the scale.
Fig. 22 shows 2° positive Caster.
Caster and KPI is measured in the same way on the other wheel.

If Caster or KPI exceeds 8° the light image should be focussed on minus 3° instead of the zero line. The measured angle will then be 3° bigger than the scale shows.

TOE-OUT on turns

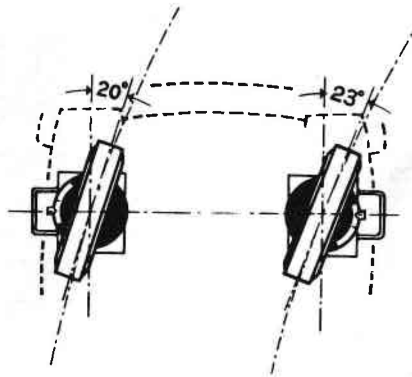


Fig. 23

Turn the LH wheel 20° inwards (outer wheel on the turn), and read the difference in the turning angles of the wheels direct on the scale of the RH turntable. Repeat the operation with the RH wheel.
Fig. 23 shows a TOE-OUT of 3° on the RH wheel (inner wheel on the turn).
For some cars other turning angles are used to measure TOE-OUT. However, in principle the measuring procedure is as indicated above.

Alignment of stiff rear axles

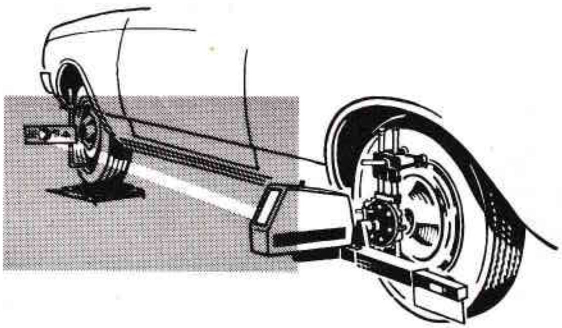


Fig. 24

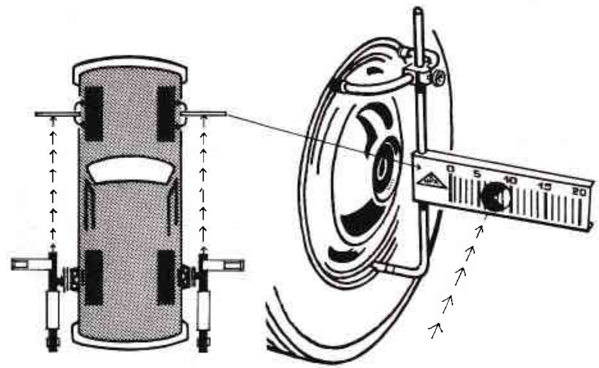


Fig. 25

Attach the RH unit to the LH rear wheel and the LH unit to the RH rear wheel. The TOE-IN projectors are now directed backwards.
Correct for untrue rims as with front wheel alignment.
Place the front wheels in straight-forward direction and place the indicators on the front wheels.
True up the measuring units and slide the indicator scales up or down until the light images of the parallel projectors are focussed.

Read the values on the indicators. If the rear axle is straight and correctly placed, the values are identical. If the values are not identical, see page 21.

Faults in Rear Axles

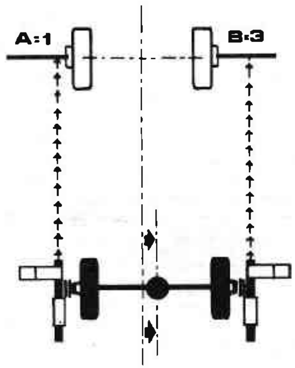


Fig. 26

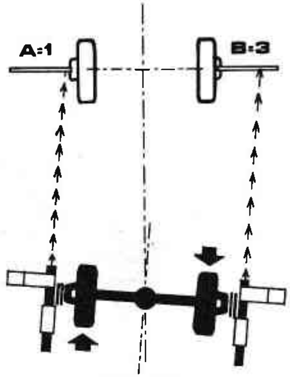


Fig. 27

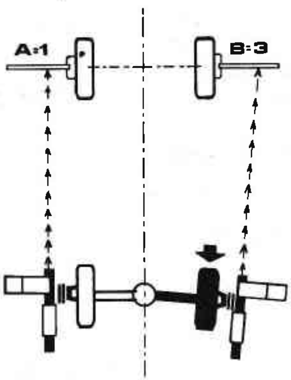


Fig. 28

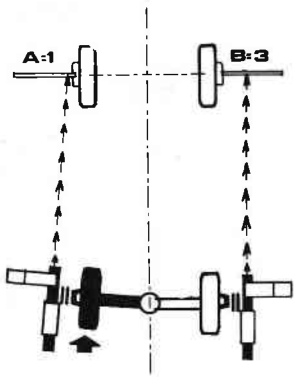


Fig. 29

In the four examples shown it is presumed that the reading on the LH indicator is A = 1 and on the RH indicator B = 3.

Fig. 26

Rear axle dislocated to the right. Check by cross-measuring.

Fig. 27

Rear axle not parallel to front axle. Check by cross-measuring.

Fig. 28

RH rear axle bent backwards.
Check by measuring whether the rear axle has TOE-IN.

Fig. 29

LH rear axle bent forwards.
Check by measuring whether the rear axle has TOE-IN.

Alignment of independent rear suspensions

Independently sprung rear wheels have TOE-IN and CAMBER just as front wheels.
In order to compensate for tensions in the rear wheel suspension, the rear wheels must be placed on roller plates.
This ensures their correct driving position.
These roller plates can be supplied as extra accessories.
Pos. No. 4001–200 (fig. 30).
Ramps are available for the roller plates.
Pos. No. 4001–201 (fig. 30).
Two of each item are used.
Alignment – see page 23 and 24.

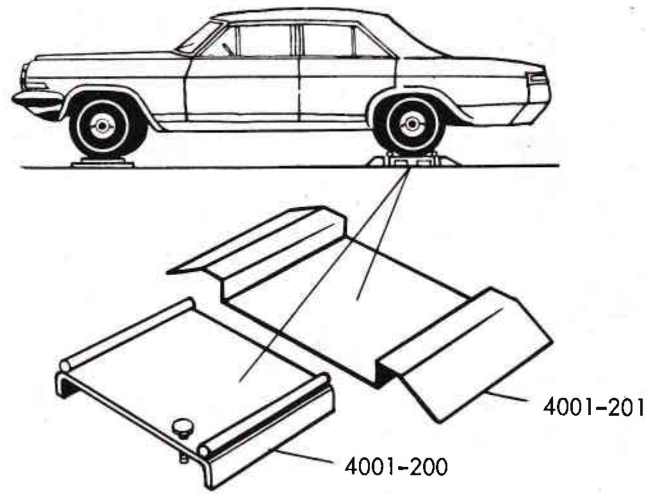


Fig. 30

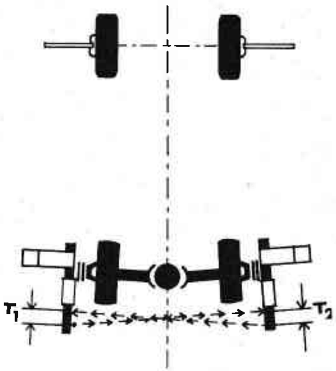


Fig. 31

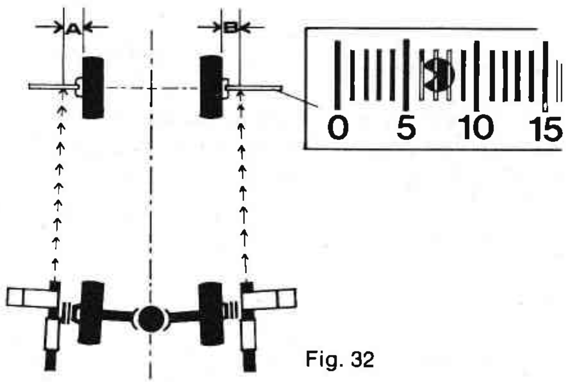


Fig. 32

Place the RH measuring unit on the LH rear wheel and the LH unit on the RH rear wheel. The TOE-IN projectors are now directed backwards.
Jack up the rear wheels and make correction for untrue rims as with front wheel alignment.
Lower the rear wheels onto the roller plates. The locking screws of the plates must be free.
Place the front wheels in "straight-ahead" position. Load the car, if prescribed.
Bump the car with the rear fender and lock the roller plates.

True up the measuring units and measure TOE-IN. The sum of the TOE-IN values T_1 and T_2 (fig. 31) is the total TOE-IN of the rear wheels.
As the measuring units are directed backwards, positive TOE-IN values should be read as negative and vice versa.

TOE-IN must be adjusted in relation to the lengthwise axis of the car and TOE-IN for each wheel is therefore measured as indicated below (fig. 32).
Place the indicators on the front wheel with the scale towards the rear wheels. Slide the scales until the light images are focussed.
If the rear wheels are correctly placed, the values A and B on the indicators are identical.
If A and B are not identical, adjustment must be made until you obtain the same values on both sides, and at the same time the total TOE-IN must be correct.
CAMBER on the rear wheels is then measured as on the front wheels.

Adjustment of independent rear suspension

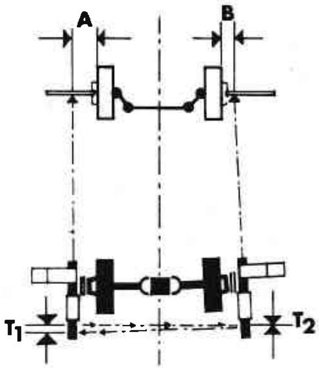


Fig. 33

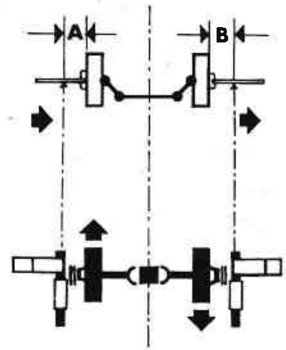


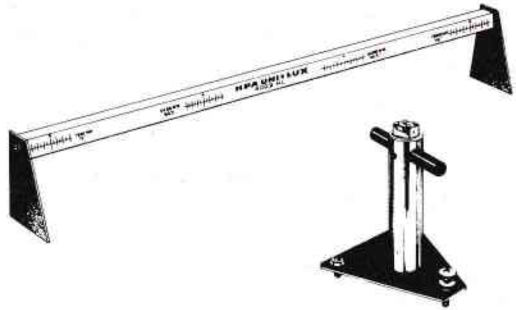
Fig. 34

The following readings are taken from car shown.
Total TOE-IN: $T_1 + T_2$ = 3 mms.
Indicator scales: A = 16
B = 10
Assuming that TOE-IN of the rear wheels is 1,5 mm the total TOE-IN value is correct, however, the distribution in relation to the lengthwise axis of the car is incorrect. When TOE-IN of the rear wheels is correct, A and B must be identical.

Medium value for A and B readings: $\frac{A+B}{2} = \frac{16+10}{2} = 13$

Adjust the rear wheels to: A = 13 and B = 13.
Check on the TOE-IN scales of the measuring units that the total TOE-IN ($T_1 + T_2$) is still 3 mms.

CHECK
A set of checking tools is supplied with the HPA UNI-LUX. If necessary corrections and adjustment are to be made as indicated on the following pages.
The tools consist of a checking rod and a checking stand. Mount one measuring unit on the mounting pivot of the checking stand. True up the spirit level by means of the thumb screw of the checking stand.
Check each measuring unit separately.
It is recommended to check the units before use, and later at regular intervals.



MAINTENANCE

Measuring units: Must be protected against shocks and blows. Use a soft, damp cloth to clean the lenses. The scales should be cleaned with mild soap or gasoline. Do not use alcohol or other solvents. The units should be protected against dust when not in use.

Mounting Fixtures: The mounting pivot for the measuring units must be oiled regularly with acid-free oil.

Indicators: Clean the scales with mild soap or gasoline. Do not use alcohol or other solvents.

Turntables: Maximum axle load allowed is 2,5 tons. The balls between the top plate and the bottom plate are made of nylon. They should not be oiled, but once in a while they must be blown clean by means of compressed air.

The guideplates in the bottom plate must be cleaned twice a year and oiled with a heavy lubricant. If the pointer has too much clearance, the guide ways can be moved thus making the distance smaller between guide plates and guide ways. If the turntables do not move easily, loosen the bottom screw (drawing 622-01, pos. 19), the thread of the screw has been dipped in glue in order not to come loose.

Transformer: Is not waterproof and should be used in dry rooms only.

Checking of TOE-IN projectors

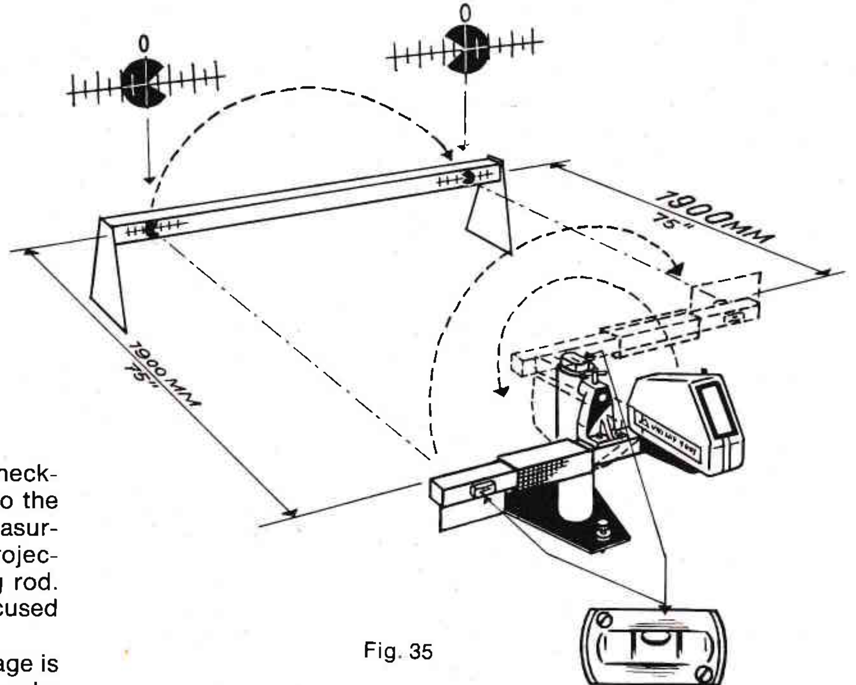


Fig. 35

Place the checking tools as shown. True up the checking stand. The checking rod should be parallel to the square arm of the measuring unit. True up the measuring unit and focus the light image of the TOE-IN projector on the horizontal centre line of the checking rod. Slide the rod sideways until the light arrow is focused on the zero line of the scale.
Turn the measuring unit 180° so that the light image is focused on the horizontal centre line of the other scale. The unit is now level again but upside down. With the unit correctly adjusted the light image should now be focused on the zero line of the scale.

Adjustment of TOE-IN projectors

1. Projector correct.
2. Projector not correct. Fault »A«.
3. Loosen screw B (Fig. 36).
4. Loosen nuts C and turn both adjusting screws D simultaneously until fault »A« is half of the former value (Fig. 36).
5. Tighten screws B and nuts C.
6. Move the checking rod until the light arrow is focused on the zero line.
7. Turn the measuring unit 180°. The light arrow should now be focused on the zero line. If not, adjustment must be repeated.

Adjust the other measuring unit in the same way.

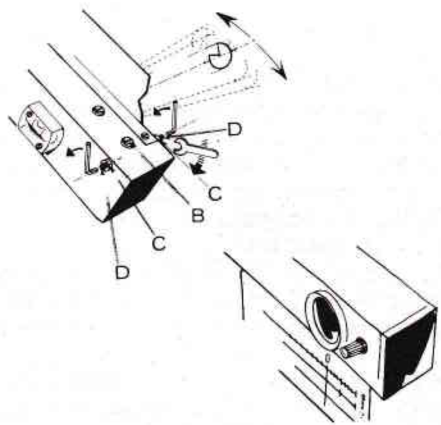


Fig. 36

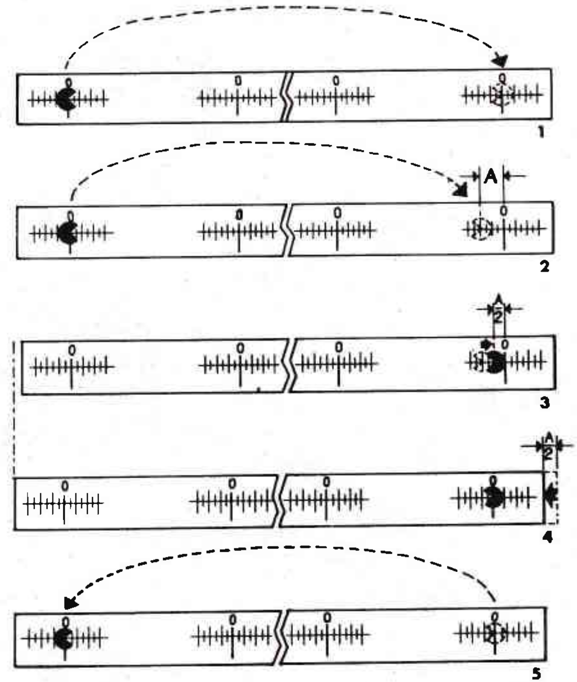


Fig. 37

Checking of parallel-projectors

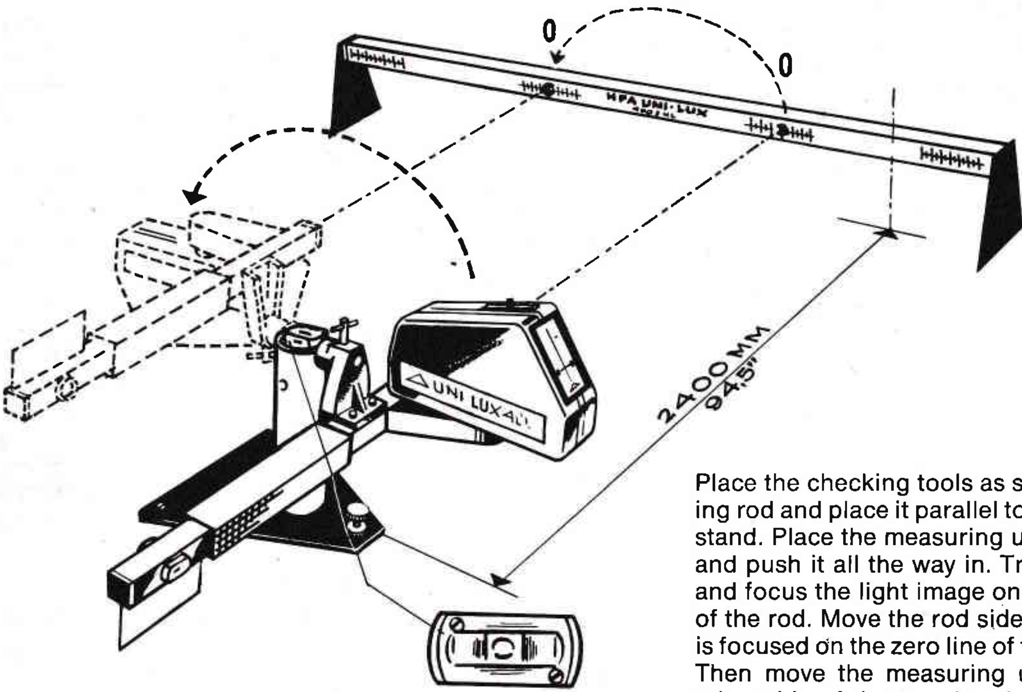


Fig. 38

Place the checking tools as shown. True up the checking rod and place it parallel to the mounting pivot of the stand. Place the measuring unit on the mounting pivot and push it all the way in. True up the measuring unit and focus the light image on the horizontal centre line of the rod. Move the rod sideways until the light image is focused on the zero line of the inner scale.

Then move the measuring unit carefully over to the other side of the stand and tilt the unit until the light image is focused once more on the horizontal line of the scale.

NB: As it is important that the checking stand is kept in position while the measuring unit is moved from one side to the other, put a foot on the bottom plate.

With a correctly adjusted unit the light image must be focused on the zero line of the scale.

1. Projector correct.
2. Projector not correct, fault "A".
3. Loosen nuts "B" and move the screws "A" (fig. 39) half the deviation towards the zero line.
   Take care that both screws are adjusted simultaneously as it is important that there is a constant pressure on the inner tube holding the lens. Retighten nuts.
4. Move the checking rod until the light arrow is focused on the zero line of the scale.
5. Move the measuring unit to the other mounting pivot as shown in fig. 38. The light arrow must now be focused on the zero line. If not, adjustment must be repeated.

Check the other measuring unit in the same way.

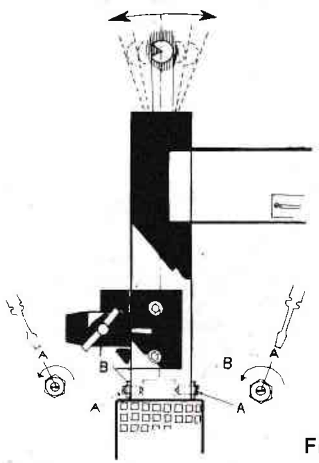


Fig. 39

Adjustment of parallel-projectors

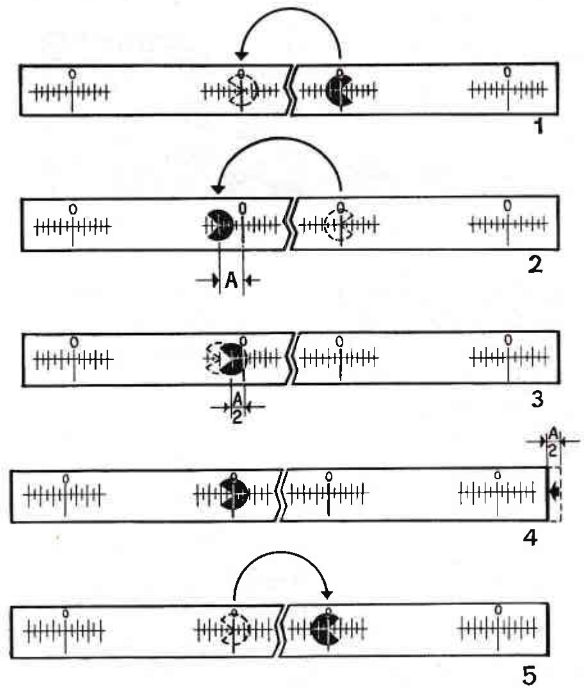


Fig. 40

Checking of CAMBER reading

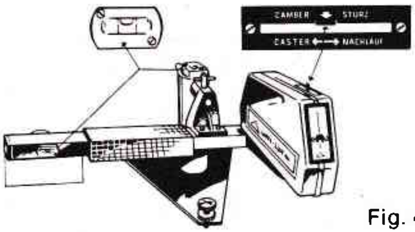


Fig. 41

True up checking stand and measuring unit. Lock the angle measuring unit at a right angle to the square arm. Place the control lever in locking position.
The light image should now be focused on the zero line of the scale.

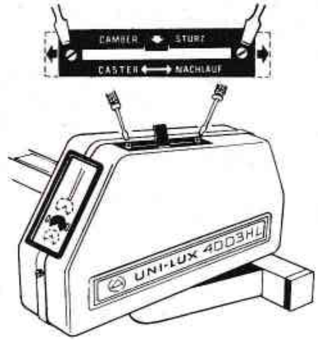


Fig. 42

Minor adjustments up or down are made by loosening the screws and sliding the top plate.

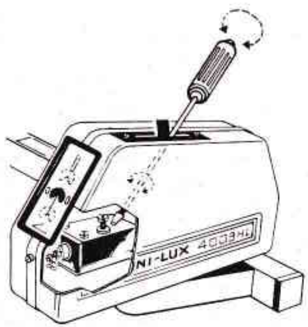


Fig. 43

If the top plate cannot be moved sufficiently, adjust by means of the adjusting screw of the lens attachment.

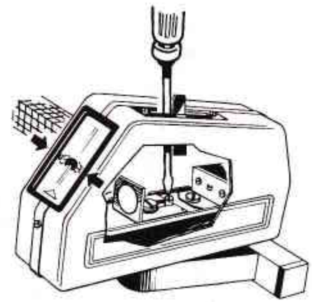
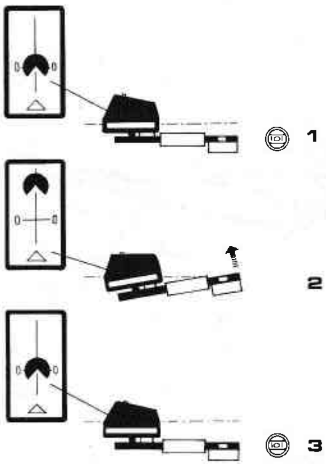


Fig. 44

Sideways adjustment of the light image is made by turning the eccentric in the lens housing.

Control of angle measuring unit

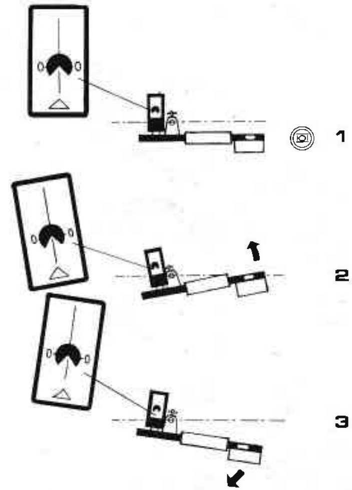
Fig. 45



True up the checking stand and place the measuring unit on the mounting pivot. Turn the angle measuring unit parallel to the square arm.

1. True up the angle measuring unit and move the control lever until the light image is focused on the zero line of the scale.
2. Tilt the measuring unit.
3. True up the unit once more. The light image must now be focused on the zero line.
   Tilt the unit in the opposite direction and check once more.

Fig. 46



Lock the angle measuring unit exactly at a right angle to the square arm.
True up the measuring unit and focus the light image on the zero line of the scale.
Move the unit lightly up and down.
Check that the light image does not move. If the light image moves, make adjustment as indicated on page 32.

If the light image does not focus on the zero line, the fault is to be found in the pendulum mirror. Remove the left cover of the angle measuring unit. See whether there is dirt between the magnets and the brake plate of the mirror. Remove dirt with a piece of paper. Check that there is about 0,1 mm tolerance between the bearing screws and the pivot shaft of the pendulum mirror. Adjust the bearing screws if necessary.

Adjustment of lock for angle measuring unit

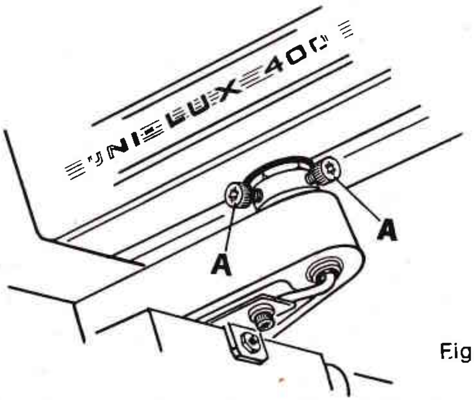


Fig. 47

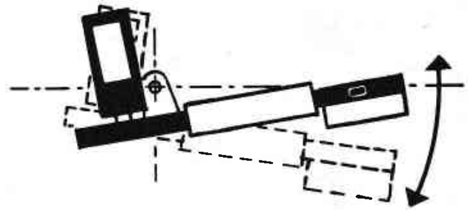


Fig. 48

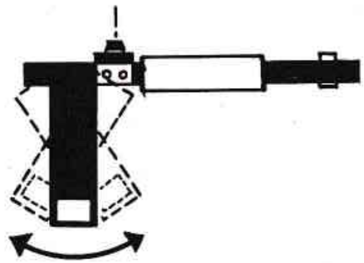
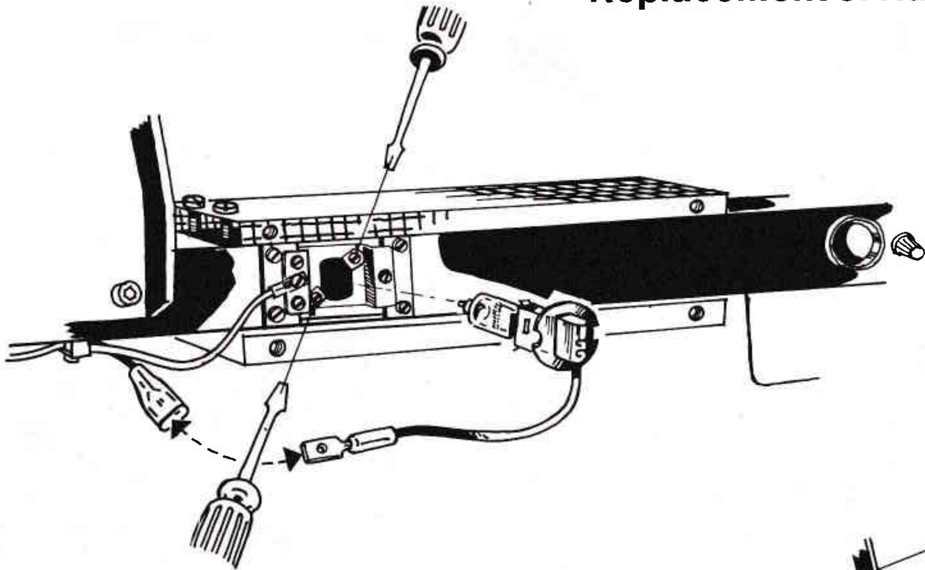


Fig. 49

The angle measuring unit must be in locking position at a right angle to the square arm.
Release the locking ring by loosening the screws A. (fig. 47).
Move the unit slowly up and down (fig. 48).
At the same time turn the unit cautiously from one side to the other (fig. 49). The locking ring must not move. Tighten the screws again, when a position is found where the light image does not move up and down (fig. 47).
If the lock is too tight or too loose, adjust the locking pivot for the locking ring. See drawing No. 4003 HL-001. Loosen the screw No. 59 and adjust the cylinder No. 56 until the lock functions correctly.

Replacement of Halogen lamp in the projector



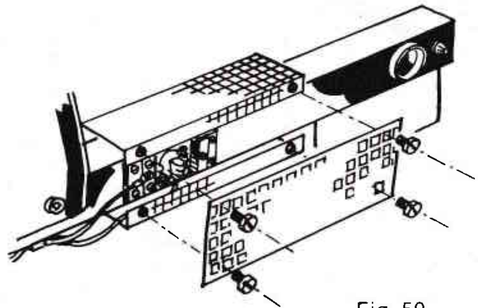


Fig. 50

The lamp to be used is:

Halogen lamp H3, 12 V, 55 W (OSRAM 64151)

Unscrew the inner cooling shield (fig. 50) and loosen the 2 screws holding the lamp. The lamp can now be removed (fig. 51).
When fitting the new lamp make sure that the filament is in vertical position.

Replacement and adjustment of lamp in the angle measuring unit

The lamps to be used are:
Automobile lamp 12 volt, 10 W (OSRAM 5008)

Remove L.H. cover. (Fig. 52)

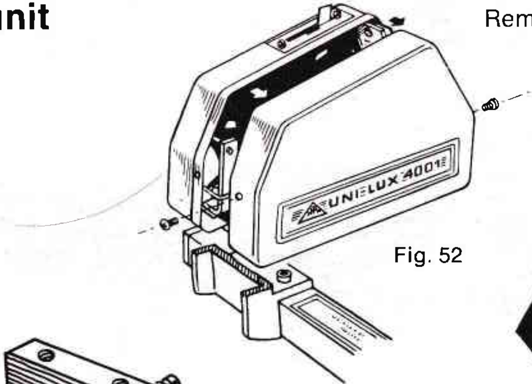


Fig. 52

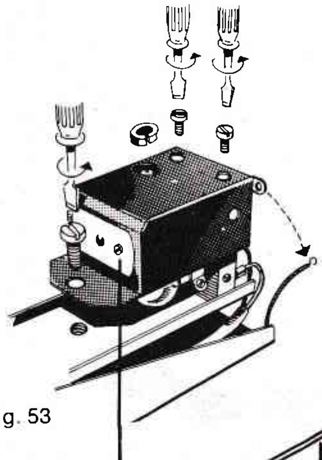


Fig. 53

A

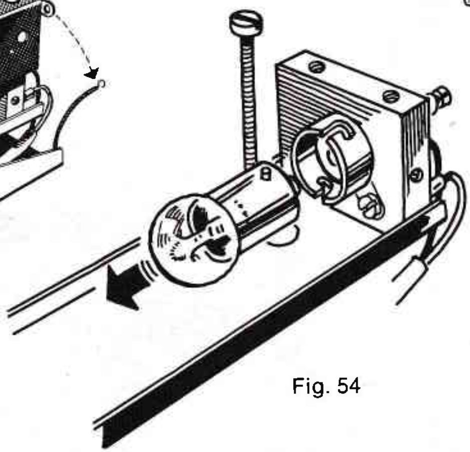
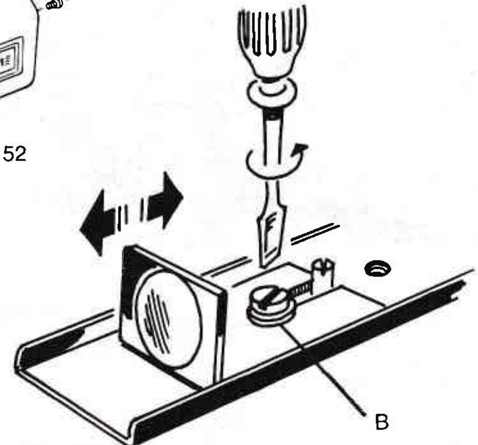


Fig. 54



B

Fig. 55

Take out the screws holding the lamp housing, and then the rubber washer beneath the adjusting screw and the tension spring. The lamp housing can now be removed (fig. 53).

Insert the new bulb into the bayonet socket (fig. 54) and fit the lamp housing.
If the light image does not focus sharply on the glass scale, loosen screw B (fig. 55) and adjust the lens holder until the light image is correctly focussed.
In case it proves impossible to focus the light image in this way, loosen screws A (fig. 53) which retain the diaphragm and adjust same.

0,97 – 1,03

Measuring Unit

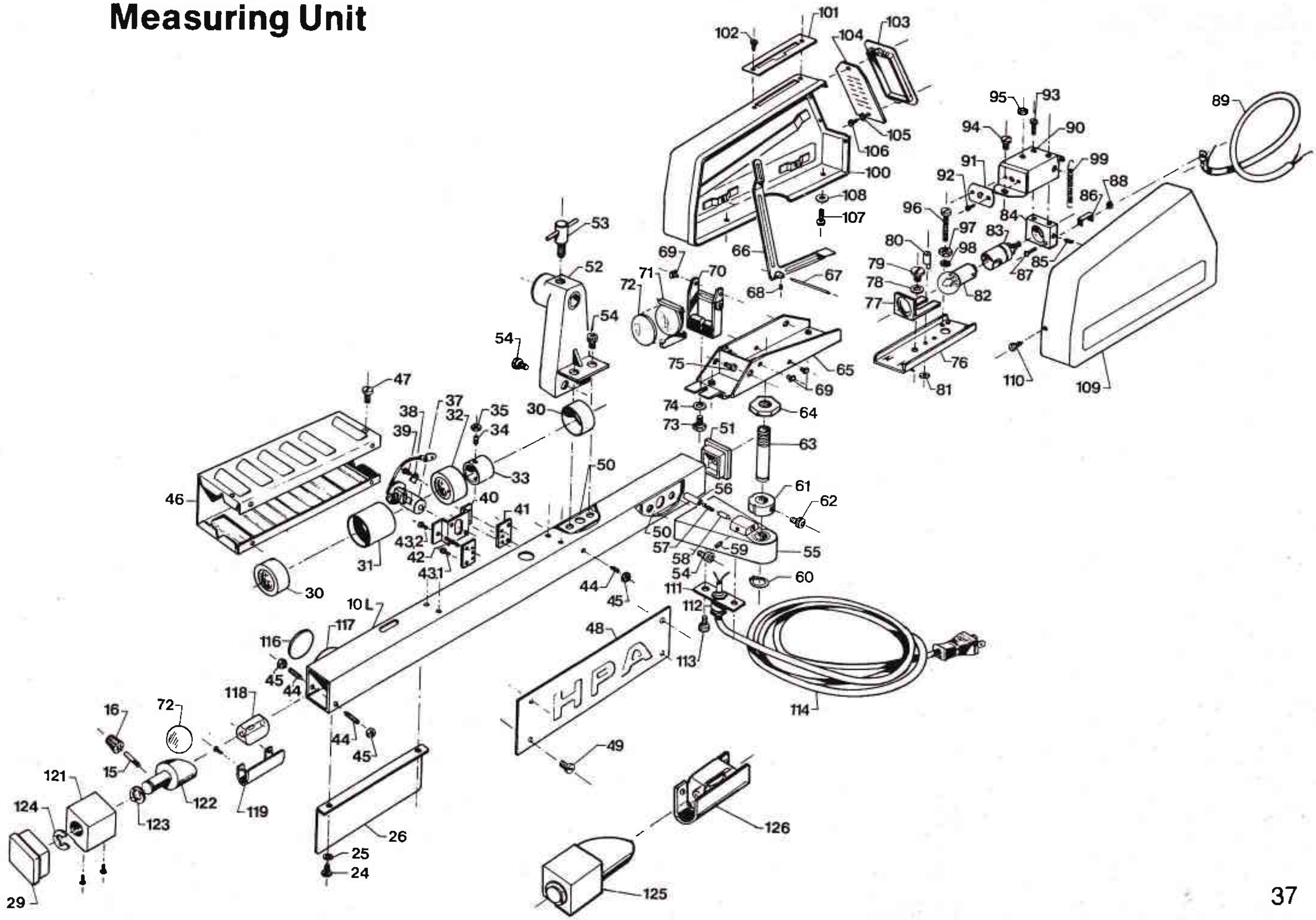
Pos. No.	Part. No.	
10L	400301001	Square arm, left
10R	400301002	Square arm, right
15	4003015	Pin
16	2703045	Knob
24	01730606	CH-cut screw, 6 × 6,5
25	11670409	Washer
26L	400302601	TOE-IN scale, L. H.
26R	400302602	TOE-IN scale, R. H.
29	4003029	Tube end
30	4003030	Objective lens (front & rear)
31	4003031	Condenser lens (front)
32	4003032	Condenser lens (rear)
33	4003033	Diaphragm
34	06650412	Grub screw, M4 × 10
35	083204	Nut, M4
37	4401026	Halogen lamp H3, 12 V–55 W, OSRAM 64151
38	4003038	Retaining plate
39	00330305	CH-screw, M3 × 5
40	4003040	Socket

Pos. No.	Part. No.	
41	4003041	Insulating plate
42	4003042	Tension spring
43-1	00330306	CH-screw, M3 × 6
43-2	00330315	CH-screw M3 × 15
44	06650416	Grub screw, M4 × 16
45	083204	Nut, M4
46	4003046	Grille
47	00330416	CH-screw, M4 × 16
48	4003048	Grille plate
49	00330306	CH-screw, M3 × 6
50	4003050	Retainer plate
51	4003051	Tube end c. w. hole
52	4001029	Support sleeve
53	4001030	T-key
54	06900616	Unbrako CH-screw, M6 × 16
55	4001032	Support bracket
56–58	4001080	Lock complete
57	4001036	Locking spring
59	07100406	Unbrako grub screw, M4 × 6
60	4001042	Circlip U 16

Pos. No.	Part. No.	
61	4001043	Retaining ring
62	06900612	Unbrako CH-screw, M6 × 12
63	4001039	Pivot
64	4001045	Lock nut, M16 × 1,5
65	4001046	Instrument base
66	4001064	Control lever
67	4001066	Pivot
68	07100304	Unbrako grub screw, M3 × 4
69	4001049	Square head screw, special cup point 1/8″
70	4001047	Pendulum housing
71	4001048	Pendulum c. w. mirror
72	4003072	Mirror 31 mm Ø
69–72	4001081	Pendulum housing c. w. mirror
73	04060406	Cap screw M4 × 6
74	11670409	Washer, 4 mm
75	00330306	CH-screw, M3 × 6
76	4003076	Base plate
77	4003077	Lens c. w. holder
78	11670612	Washer, 6 mm
79	00330610	CH-screw, M6 × 10
80	4001059	Eccentric
81	4003021	Disk
82	4003082	Automobile lamp BA 15 S, 12 V–10 W, OSRAM 5008
83	4003083	One-pole socket
84	4003084	Socket holder
85	00650408	Grub screw, M4 × 8
86	4003083	Contact plate
87	00330315	CH-screw, M3 × 15
88	083203	Nut, M3
89	4003089	Cable
90	4003090	Lamp housing

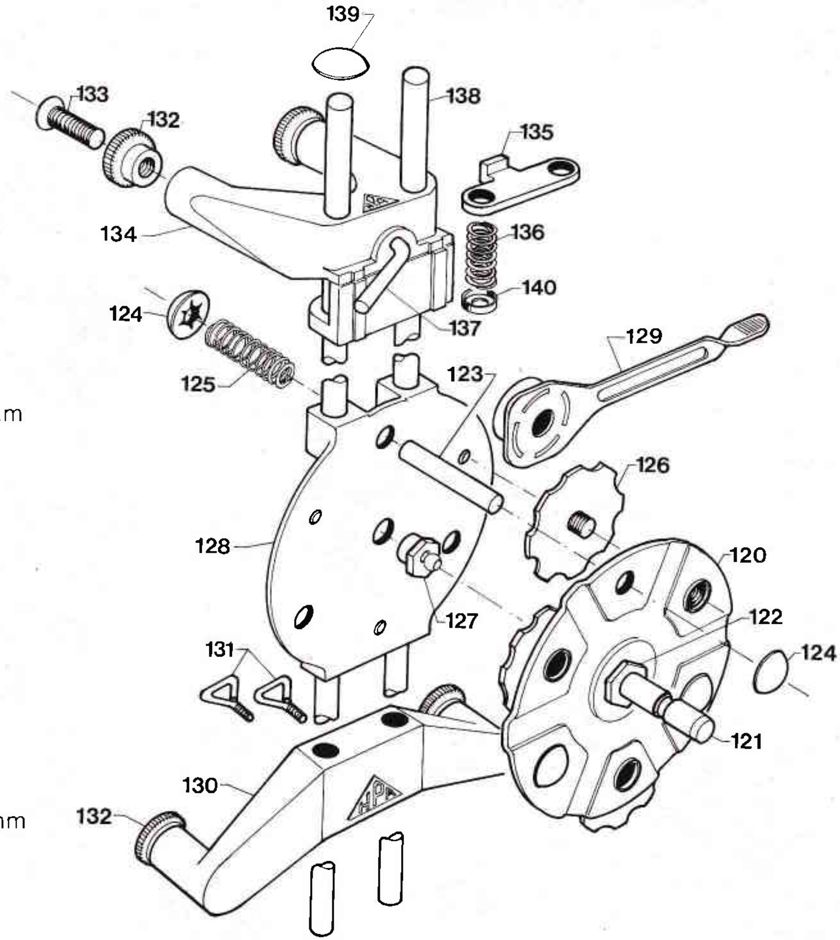
Pos. No.	Part. No.	
91	400309	Diaphragm
92	01730205	CH-sheet metal screw, 2 × 5
93	00330405	CH-screw, M4 × 5
94	00330605	CH-screw, M6 × 5
95	4003095	Rubber bushing
96	00330450	CH-screw, M4 × 50
97	083204	Nut, M4
98	4001054	Rubber busing
99	4003099	Tension spring
100	4001067	Firm cover
101	4001072	Guide plate
102	01730205	CH-sheet metal screw, 2 × 5
103	4001082	Frame
104	4001074	Glass scale
105	4001075	Rubber disk
106	01730406	CH-sheet metal screw, 4 × 6,5 mm
107	00330406	CH-screw, M4 × 6
108	11670409	Washer, 4 mm
109	4001068	Loose cover
110	01730406	CH-sheet metal screw, 4 × 6,5 mm
111	4003111	Fitting plate
112	2703069	Cable gland, PG9
113	00330608	CH-screw, M6 × 8
114	406111	Cable 2 × 1,5 mm^2, 3 metres c.w. plug
116	2701024	Front glass, 31 Ø
117	403117	Frame for front glass
118	403118	Spirit level
119	403119	Bracket for spirit level
121	403121	Housing for mirror holder
122	403122	Mirror holder
123	403123	Pressure disk
124	403124	Circlip
125	403125	Mirror holder c.w. housing (RH or LH)
126	403126	Spirit level c. w. bracket

Measuring Unit

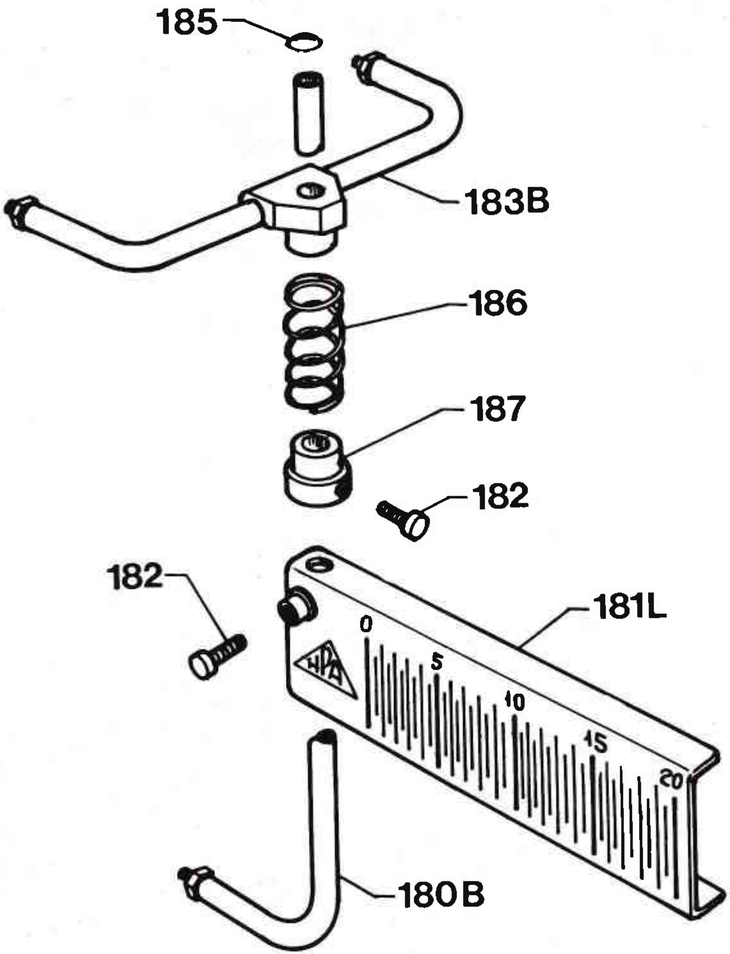


Mounting Fixture

Pos. No.	Part No.	
120	4001100	Compensator plate
121	4003101	Mounting pivot
122	4001102	Lock nut 16 × 1,5 MFG
123	4001103	Pin, plain
124	4001104	STARLOCK locking disk 10 mm
125	4001105	Spring
126	4001107	Compensator screw
127	270146	Guide pin
128	4001108	Guide plate
129	4001109	Cam lock
130	4001111	Supporting bracket
131	4001112	Wing screw 6 mm
132	4001113	Lock nut
133	4001114	Cut screw
134	4001115	Loose beam
137	4001116	Eccentric
135	4001117	Locking bracket
136	4001118	Spring
138	4001119	Guide rod
139	4001121	STARLOCK locking disk 14 mm
140	401118-2	Thrust washer

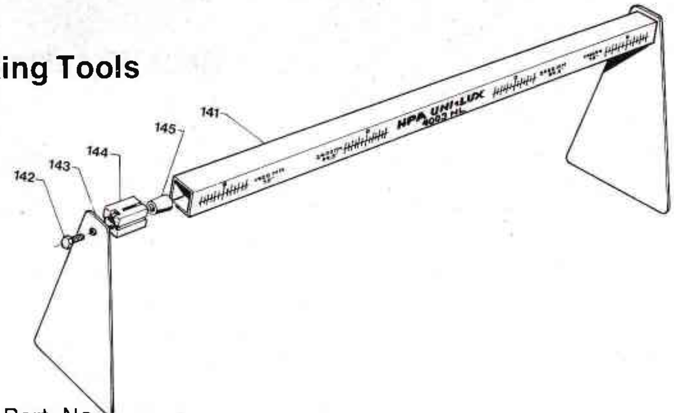


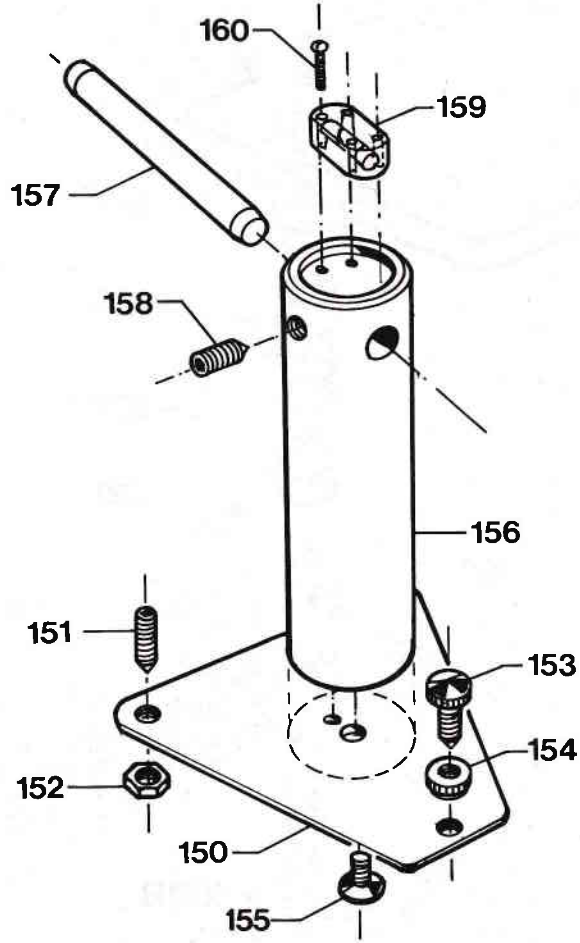
Rear Wheel Indicator



Pos. No.	Part. No.	
180 B	4001188	Vertical tube
181 L	400118101	Scale, left
181 R	400118102	Scale, right
182	4001182	Thumb screw
183 B	4001189	Upper bracket
185	4001185	Locking disk 12 mm
186	4001186	Pressure spring
187	4001187	Stop ring

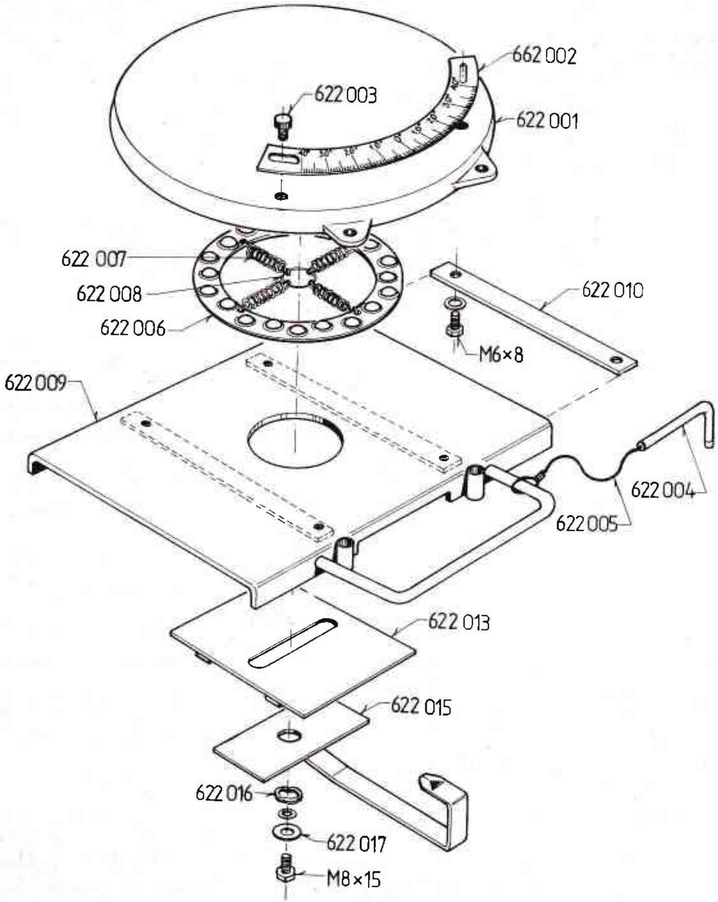
Checking Tools





Pos. No.	Part. No.	
141	4003141	Checking rod
142	04060625	Cap screw, M6 × 25
143	4003143	End plate
144	484158	Expander
145	484159	Cone
150	4001135	Plate
151	06650820	Grub screw, M8 × 20
152	083208	Nut M8
153	4001137	Adjusting screw, M8
154	4001113	Counter nut, M8
155	07230825	Unbrako MK, M8 × 25
156	4003156	Stand
157	4003157	Cross pin
158	07100612	Unbrako MSP, M6 × 12
159	4003153	Spirit level
160	00330322	R. H.-screw, M3 × 22

Turntables



Part. No.	
622001	Top plate
622002	Scale
622003	CH-screw, M6
622004	Locking pin
622006	Pressure bearing
622007	Spring
622008	Centre ring
622678	Pressure bearing, complete
622009	Bottom plate
622010	Guide way, long
12200611	Toothed disk, 6 mm
04060608	Set screw, M6×8
622013	Guide plate
622015	Guide plate with pointer
622016	Pressure disk
11720835	Disk, ∅ 35 × ∅ 8 × 2 mm
12200815	Toothed disk, 8 mm
04060815	Set screw, M8×15

CONVERSION TABLES FOR TOE-IN

British and American inches converted into millimetres (round figures)

inch.	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2
mm	0,8	1,6	2,4	3,2	4,0	4,8	5,6	6,4	7,1	7,9	8,7	9,5	10,3	11,1	11,9	12,7

British and American inches in decimal system converted into millimetres (round figures)

inch.	0,02	0,04	0,06	0,08	0,1	0,12	0,14	0,16	0,18	0,20	0,22	0,24	0,26	0,28	0,30	0,32
mm	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,1	5,6	6,1	6,6	7,1	7,6	8,1

Grades and minutes ($1^\circ = 60'$) converted into millimetres in relation to rim size (round figures)

	0° 5'	0° 10'	0° 15'	0° 20'	0° 25'	0° 30'	0° 35'	0° 40'	0° 45'	0° 50'	0° 55'	1° 0'	1° 5'	1° 10'	1° 15'	1° 20'	1° 25'	1° 30'
10"	0,4	0,8	1,2	1,6	2,0	2,4	2,9	3,3	3,7	4,1	4,5	5,0	5,4	5,8	6,2	6,6	7,0	7,4
12"	0,5	1,0	1,5	2,0	2,4	2,9	3,4	3,9	4,4	4,9	5,4	5,8	6,3	6,8	7,3	7,8	8,2	8,8
13"	0,5	1,0	1,5	2,1	2,6	3,2	3,7	4,2	4,7	5,3	5,8	6,3	6,8	7,4	7,9	8,4	8,9	9,5
14"	0,6	1,1	1,7	2,3	2,8	3,4	4,0	4,6	5,1	5,7	6,3	6,8	7,4	8,0	8,5	9,1	9,7	10,2
15"	0,6	1,3	1,9	2,5	3,1	3,8	4,4	5,0	5,6	6,2	6,9	7,5	8,1	8,7	9,3	9,9	10,6	11,2
16"	0,7	1,3	2,0	2,6	3,3	3,9	4,6	5,2	5,9	6,5	7,2	7,8	8,5	9,1	9,8	10,4	11,1	11,7